Dental Anthropological Study of Chinese Ethnic Minority, Miao, with Reference to Other Minorities and Asian Populations

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Abstract

Department of Anatomy and Physical Anthropology, Nihon University School of Dentistry at Matsudo made a dental anthropological survey of a Chinese minority in Annin in Yunnan Province in 2007. Subjects were young adults of the Miao people historically derived from South-east Asian area from whom dental impression models were collected. The frequencies of 22 dental non-metric traits of 7 maxillary and 4 mandibular teeth were recorded. Measurements of the teeth were also made by a digital caliper with the precision of 1/100 mm on mesiodistal and buccolingual diameters of each tooth. The results were compared with those of previous studies including Chinese minorities, Dai, Hani and Naxi, Pumi and with other Asian populations. A principal coordinate analysis based on Smith's Mean Measure of Divergence using the frequencies of 17 traits suggested that the Miao belonged to the Sundadont dentition category, which typifies Southeast Asians and positioned close to the Hani. Statistics and multi-variate analysis of the metric study showed that the Miao had relatively small teeth compared with other four minorities in Yunnan Province. Based on our findings, and presumed past and present distributions of Sinodonty and Sundadonty, it was suggested that the Miao in Yunnan Province have genetically inherited traits similar to the Sundadont peoples of South-east Asian to which other four minorities also belonged. However, different combination of the frequent dental traits and small size of the teeth in Miao might suggest that the Miao occupies a different position of their affinity from other four minorities.

Keywords :

Chinese minority, Miao, dental traits, tooth size, Yunnan, dental anthropology

Introduction

There are 55 ethnic minorities in China, most of which have been living in Yunnan Province (1). Physical anthropological studies such as anthropometry and craniometry on these groups have been accomplished mainly by Chinese Academy (2, 3, 4). However, dental anthropological characteristics of these groups have not been fully studied. Dental morphology and odontometry occupy an important position in anthropological investigations for reconstruction of ethnic affinities among these minorities and the relationships between these tribes and peoples in Asia. In recent years, dental anthropological studies for 4 Chinese minorities, the Dai, Hani, Naxi

and Pumi tribe were carried out by Nihon University Dental Survey Team in 2000, 2002 at Yuen Jian and Li Jian in Yunnan Province, China in which both metric and non-metric studies were carried out (5, 6, 7). These studies showed that the tooth sizes were relatively small and that the non-metric traits showed Sundadont characteristics.

The Miao ethnic minority is another ethnic group with relatively large population in Yunnan Province. However, their dental anthropological characters have not been reported yet. The purposes of this study were to describe the frequencies of dental traits and the size of the teeth of Miao people and to compare them with other minorities and Asian peo-

ples in multivariate analysis.

Materials and Methods

Materials were dental plaster casts of permanent dentition collected from Miao villagers at the city of Anning near Kunming. They were 16 to 28 years of age being mainly engaged in agricultural work on vegetables and tobacco leaf. Dental traits for observation were well preserved in this age range without severe attrition.

Dental casts of the Miao (38 males and 62 females) were stored in Nihon University School of Dentistry at Matsudo. The parameters recorded in this study were 22 crown traits classified by the Arizona State University Dental Anthropology System (8). These are listed in Table 1 to Table 22, where the grades or scores for each trait are also shown. Most of these traits have previously been used to explicate modes of inheritance and heritability, and the frequencies of these traits can be regarded as population characteristics (8, 9, 10). The data from males and females were pooled because there were no significant differences (at 5% level) between the sexes in the frequencies of all 22 traits measured in this study.

A four-point scale was used for scoring of the traits involving none (–), trace (±), present (+) and strong (++), except for the following cases: interruption groove and winging in the upper incisor (6-point and 5-point scales respectively), odontome in the premolars (2-point scale i.e. present or absent), lingual cusp variation in the lower molars and hypocone reduction in the upper molars (4 levels based on a combination of cusp numbers and their size), Carabelli's trait in the upper molars (5-point scale), and distal trigonid crest in the lower molars and cusp number in the lower molar (2-point scales).

In the comparison of the Miao frequencies with those of the 30 other East Asian populations, the number of crown parameters was reduced to 17, and the number of levels in the various scales was reduced to two, with all points above 1 (2-4, 2-5, 2-6) combined into one score (7). Thus the frequencies for each parameter were expressed simply as present or absent. Using the frequencies of the 17 traits, Smith's Mean Measure of Divergence (MMD), together with the Freeman-Tukey method for inverse sine transformation, was used to determine inter-population distances, (11, 12, 13). Affinity between the Miao and

Table 1. Teeth and frequencies of shoveling in the Miao (sexes pooled).

Expression	UI1		UI2	
	N	%	N	%
– : None	8	8.51	2	2.22
± : Trace	28	29.79	35	38.89
+ : Present	51	54.26	44	48.89
++ : Strong	5	5.32	3	3.33
Total	92		84	

Table 2. Teeth and frequencies of double-shoveling in the Miao (sexes pooled).

Expression	UI1		UI2	
	N	%	N	%
– : None	29	30.85	59	64.13
± : Trace	49	52.13	24	26.09
+ : Present	16	17.02	2	2.17
++ : Strong	0	0.00	0	0.00
Total	94		85	

Table 3. Teeth and frequencies of tuberculum dentale in the Miao (sexes pooled).

Expression	UI1		UI2		UC	
	N	%	N	%	N	%
– : None	53	56.99	81	96.43	27	27.84
± : Trace	30	32.26	1	1.19	59	60.82
+ : Present	11	11.83	2	2.38	11	11.34
++ : Strong	0	0.00	0	0.00	0	0.00
Total	94		84		97	

Table 4. Teeth and frequencies of spinal process in the Miao (sexes pooled).

Expression	UI1		UI2	
	N	%	N	%
– : None	87	93.55	82	96.47
± : Trace	5	5.38	2	2.35
+ : Present	1	1.08	1	1.18
++ : Strong	0	0.00	0	0.00
Total	93		85	

Table 5. Teeth and frequencies of interruption groove in the Miao (sexes pooled).

Expression	UI1		UI2	
	N	%	N	%
— : None	93	100	79	92.94
MB: Mesiolingual border	0	0.00	4	4.71
DB: Distlingual border	0	0.00	1	1.18
MD: Mesio and distlingual border	0	0.00	1	1.18
MA: Mesial area	0	0.00	0	0.00
DA: Distal area	0	0.00	0	0.00
Total	93		85	

Table 6. Teeth and frequencies of winging in the Miao (sexes pooled).

Expression	UI1	
	N	%
C+ : Present (counter winging)	12	12.63
C± : Trace (counter winging)	15	15.79
— : None	45	47.37
± : Trace	12	12.63
+ : Present	11	11.58
Total	95	

Table 7. Teeth and frequencies of canine mesial ridge in the Miao (sexes pooled).

Expression	UC	
	N	%
— : None	82	87.23
± : Trace	5	5.32
+ : Present	6	6.38
++ : Strong	1	1.06
Total	94	

Table 8. Teeth and frequencies of canine distal accessory ridge in the Miao (sexes pooled).

Expression	UC	
	N	%
— : None	52	59.77
± : Trace	25	28.74
+ : Present	10	11.49
++ : Strong	0	0.00
Total	87	

Table 9. Teeth and frequencies of accessory marginal tubercle in the Miao (sexes pooled).

Expression	UP1		UP2	
	N	%	N	%
— : None	30	32.26	55	66.27
± : Trace	31	33.33	12	14.46
+ : Present	32	34.41	11	13.25
++ : Strong	0	0.00	5	6.02
Total	93		83	

Table 10. Teeth and frequencies of odontomes in the Miao (sexes pooled).

Expression	UP1		UP2		LP1		LP2	
	N	%	N	%	N	%	N	%
— : None	100	100	98	100	95	97.94	96	97.96
+ : Present	0	0.00	0	0.00	2	2.06	2	2.04
Total	100		98		97		98	

Table 11. Teeth and frequencies of lingual cusp variation in the Miao (sexes pooled).

Expression	LP1		LP2	
	N	%	N	%
0 : None	7	7.14	0	0.00
1 : One lingual cusp	81	82.65	61	61.62
2 : Two lingual cusp	10	10.20	38	38.38
3 : Three lingual cusp	0	0.00	0	0.00
Total	98		99	

Table 12. Teeth and frequencies of hypocone reduction in the Miao (sexes pooled).

Expression	UM1		UM2	
	N	%	N	%
4+ : Large cusp	73	78.49	5	5.68
4- : Small cusp	16	17.20	23	26.14
3+ : Faint cusp	4	4.30	37	42.05
3- : None or faint ridge	0	0.00	23	26.14
Total	93		88	

Table 13. Teeth and frequencies of metacone reduction in the Miao (sexes pooled).

Expression	UM1		UM2	
	N	%	N	%
— : None	81	88.04	9	10.23
± : Trace	11	11.96	53	60.23
++ : Present	0	0.00	26	29.55
+++ : Strong	0	0.00	0	0.00
Total	92		88	

Table 14. Teeth and frequencies of cusp 5 in the Miao (sexes pooled).

Expression	UM1		UM2	
	N	%	N	%
— : None	69	83.13	77	90.59
± : Trace	8	9.64	4	4.71
++ : Present	6	7.23	4	4.71
+++ : Strong	0	0.00	0	0.00
Total	83		85	

Table 15. Teeth and frequencies of Carabelli's trait in the Miao (sexes pooled).

Expression	UM1		UM2	
	N	%	N	%
— : None	58	60.42	91	92.86
± : Line	13	13.54	2	2.04
± : Trace	15	15.63	4	4.08
++ : Tubercle	9	9.38	1	1.02
+++ : Cusp	1	1.04	0	0.00
Total	96		98	

Table 16. Teeth and frequencies of protostylid in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
— : None	75	82.42	88	91.67
± : Trace	14	15.38	6	6.25
++ : Tubercle	2	2.20	2	2.08
+++ : Cusp	0	0.00	0	0.00
Total	91		96	

Table 17. Teeth and frequencies of deflecting wrinkle in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
— : None	45	56.25	87	96.67
± : Trace	25	31.25	3	3.33
++ : Present	10	12.50	0	0.00
+++ : Strong	0	0.00	0	0.00
Total	80		90	

Table 18. Teeth and frequencies of distal trigonid crest in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
— : Abscent	82	100	92	100
++ : Present	0	0.00	0	0.00
Total	82		92	

Table 19. Teeth and frequencies of cusp 6 in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
— : None	44	64.71	47	74.60
± : C5>C6	10	14.71	5	7.94
++ : C5=C6	11	16.18	9	14.29
+++ : C5<C6	3	4.41	2	3.17
Total	68		63	

Table 20. Teeth and frequencies of cusp 7 in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
— : None	84	94.38	92	98.92
± : Faint cusp	1	1.12	0	0.00
++ : Small cusp	4	4.49	1	1.08
+++ : Large cusp	0	0.00	0	0.00
Total	89		93	

Table 21. Teeth and frequencies of groove pattern in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
Y pattern	65	86.67	8	10.39
+ pattern	8	10.67	36	46.75
X pattern	2	2.67	33	42.86
Total	75		77	

Table 22. Teeth and frequencies of cusp number in the Miao (sexes pooled).

Expression	LM1		LM2	
	N	%	N	%
4 : 4 cusp	0	0.00	12	17.65
5 : 5 cusp	78	100	56	82.35
Total	78		68	

other Asian populations was expressed on two dimensions of the principal coordinate analysis based on Smith's MMD.

For metric study, the teeth on the right side of the maxillary and mandibular arches were measured except for third molars by digital calipers with the accuracy of 0.01 mm. Any tooth with obvious dental abnormalities, excessive wear, caries, impression flaws, partial eruption, or fillings that obscured the proper placement of caliper beaks was excluded. When a tooth on the right side was not available according to these disturbances, corresponding tooth on the left side was measured.

The statistical test, i.e., the MMD, the principal coordinate analysis, and the Chi-square test for sex differences, Student's t-test were all carried out on a

personal computer using the JMP statistical package (SAS Institute Inc. ver. 6).

Results

The frequencies of the 22 non-metric traits of the upper and lower dentition were shown in Table 1 to Table 22. They are expressed by individual count and percentage. Because of differences in the number of observable cases, total sample numbers differ from trait to trait. Table 23 shows the dichotomized frequencies of the 17 analyzed traits in the Miao to compare with those of other Asian populations. Hypocone reduction at the levels of 4 and 3 in upper second molar had the highest frequency among the 17 traits. Deflecting wrinkle and distal trigonid crest in the lower first molar had the lowest frequency at 0.0.

Dichotomized frequencies of the 17 traits in 30 populations of East Asia and those of the Miao tribe are shown in Table 24. Frequencies for the populations other than the Miao were taken from already published studies (9, 14-24). The traits which showed a relatively high frequency in the Miao compared with other Chinese minorities, the Dai, Hani, Naxi and Pumi were hypocone reduction in UM1, Cusp 6

Table 23. Dichotomized frequency of 17 selected traits in the Miao

Trait	Tooth	Expression dichotomy*	Frequency in Miao (%)
Shoveling	UI1	(++ , +)/(++ ~ -)	60.87
Double-shoveling	UI1	(++ , +)/(++ ~ -)	17.02
Tuberculum dentale	UI2	(++ ~ ±)/(++ ~ -)	3.57
Mesial ridge	UC	(++ ~ ±)/(++ ~ -)	12.77
Distal accessory ridge	UC	(++ ~ ±)/(++ ~ -)	40.23
Lingual cusp variation	LP2	(3, 2)/(3 ~ 0)	38.38
Odontomes	U-L, P1-2	(+)/(+ , -)	2.06
Hypocone	UM2	(4+ ~ 3+)/(4+ ~ 3-)	73.86
Cusp 5	UM1	(++ ~ ±)/(++ ~ -)	16.87
Carabelli's trait	UM1	(++ , +)/(++ ~ -)	10.42
Protostylid	LM1	(++ ~ ±)/(++ ~ -)	17.58
Deflecting wrinkle	LM1	(+)/(++ ~ -)	0.00
Distal trigonid crest	LM1	(+)/(+ , -)	0.00
Cusp 6	LM1	(++ ~ ±)/(++ ~ -)	35.29
Cusp 7	LM1	(++ ~ ±)/(++ ~ -)	5.62
Y groove pattern	LM2	(Y)/(Y , + , X)	10.39
Cusp number	LM2	(4)/(5, 4)	17.65

* : (Present range of grades)/(total range of grades)

Table 24. Numbers of samples and dental trait frequencies (Total N, Present %) in East Asian population samples.

	UI1		UII		UI2		UC		UC		LP2		U, LPI, 2		UM2	
Miao	92	60.87	94	17.02	84	3.57	94	12.77	87	40.23	99	38.38	97	2.06	88	73.86
Pumi	76	63.16	84	10.71	83	7.23	80	7.50	72	22.22	86	67.44	88	1.14	78	88.46
Naxi	92	64.13	97	13.40	97	14.43	90	11.11	85	55.29	96	46.88	97	1.03	85	78.82
Hani	80	55.00	86	15.12	86	9.30	76	7.89	66	51.52	86	51.16	87	1.15	88	84.09
Dai	89	33.71	93	45.16	98	39.80	90	0.00	92	53.26	96	67.71	96	1.04	95	84.21
Dafur	172	51.20	172	32.00	168	16.70	166	11.20	172	65.70	173	81.50	167	1.10	156	78.30
Hui	162	58.00	155	46.50	165	10.30	167	10.20	164	50.00	166	83.70	168	2.40	150	92.00
Chaoxian	167	68.90	165	50.30	167	14.40	166	11.40	163	52.10	165	80.00	167	0.50	156	85.20
Man	208	61.60	200	42.50	205	4.40	211	8.10	212	53.80	210	93.30	211	0.50	201	88.50
Han	145	56.60	143	23.10	136	14.70	147	4.80	147	67.30	147	83.00	139	0.70	129	89.20
Bali	172	25.00	169	12.40	171	7.60	173	1.70	168	64.80	172	73.30	172	0.60	169	94.10
Bunun	95	76.84	90	42.22	93	24.73	86	6.98	88	69.32	93	80.65	94	1.06	71	88.73
Ami	146	70.55	141	33.33	139	16.55	135	5.93	134	61.19	144	85.42	145	2.76	129	83.72
Yami	192	70.31	191	23.04	189	15.87	155	10.32	157	68.79	153	88.89	155	1.29	106	80.19
Lake Baikal	13	92.31	10	50.00	16	25.00	16	6.25	3	33.33	11	72.73	6	0.00	24	100
Amur	16	68.75	18	44.44	27	11.11	27	11.11	13	53.85	39	71.79	40	5.00	52	82.69
N China-Mongolia	200	84.00	213	30.05	246	19.11	255	2.35	125	66.40	276	81.16	231	3.90	406	90.39
Recent Japan	276	65.94	267	19.48	304	15.46	365	3.01	240	57.92	341	65.98	462	4.98	482	86.51
Jomon	117	25.64	138	1.45	201	23.88	136	2.21	49	69.39	294	63.61	260	0.38	206	82.04
Hong Kong P	307	63.84	299	28.43	298	19.13	305	2.95	249	54.62	319	66.46	314	7.64	299	90.30
S China P	35	74.29	33	24.24	44	11.36	55	3.64	26	80.77	72	77.78	94	0.00	93	86.02
Prehistoric Taiwan	22	59.09	21	0.00	14	14.29	10	0.00	7	42.86	24	79.17	17	0.00	27	85.19
Philippines	54	42.59	29	17.24	58	22.41	76	2.63	39	61.54	89	66.29	116	2.59	148	83.78
Early Mainland (SeA)	99	32.32	100	10.00	113	27.43	120	2.50	44	56.82	157	76.43	83	1.20	189	93.12
Recent SE Asia	13	46.15	14	28.57	17	23.53	39	2.56	17	41.18	52	61.54	63	3.17	102	87.25
Recent Thailand P	127	37.01	111	9.01	128	19.53	143	7.69	80	47.50	147	63.95	189	4.23	196	89.80
Burma	15	13.33	13	0.00	26	11.54	33	6.06	16	62.50	25	44.00	57	1.75	95	94.74
Nepal	10	20.00	11	9.09	9	22.22	17	0.00	9	66.67	13	61.54	38	2.63	58	86.21
Recent Indomalaysia	49	24.49	36	11.11	57	28.07	82	6.10	39	71.79	112	78.57	147	0.68	215	91.16
Early Malay Archipelago	71	29.58	67	28.36	84	32.14	103	9.71	63	50.79	105	85.71	120	4.17	156	89.10
East Malay Archipelago	12	8.33	3	0.00	13	23.08	16	6.25	9	88.89	21	71.43	25	0.00	29	86.21

Cusp 5	Carabelli's trait		Protostylid		DW	DTC	Cusp 6		Cusp 7	YGP		Cusp number					
	UM1	UM1	LM1	LM1			LM1	LM1		LM2	LM2						
83	16.87	96	10.42	91	17.58	80	0.00	82	0.00	68	35.29	89	5.62	77	10.39	68	17.65
75	24.00	85	22.35	76	30.26	64	1.56	66	4.55	57	21.05	77	1.30	71	4.23	72	50.00
87	12.64	89	5.62	77	23.38	68	1.47	65	0.00	64	23.44	81	1.23	80	5.00	76	34.21
86	17.44	90	15.56	86	32.56	67	1.49	56	12.50	76	7.89	88	3.41	79	3.80	79	53.16
93	29.03	93	16.13	88	39.77	82	1.22	68	1.47	86	30.23	90	4.44	90	4.44	90	48.89
159	17.00	163	35.60	153	60.80	158	21.50	152	7.20	150	54.00	157	10.20	160	3.80	155	32.90
166	23.50	157	45.80	161	31.70	159	32.70	158	5.10	159	34.00	160	8.10	153	4.60	147	29.90
153	26.80	157	49.60	151	27.20	152	6.60	155	0.00	153	39.90	156	6.40	161	2.50	160	34.40
212	25.50	212	33.90	210	32.40	209	28.20	209	6.20	209	34.00	208	5.80	209	2.90	207	35.80
130	20.00	135	16.20	125	19.20	107	30.80	115	7.80	115	40.90	115	5.20	115	0.90	112	27.70
168	29.20	169	59.10	162	4.90	146	13.00	154	1.90	157	20.40	162	8.00	51	0.00	155	40.60
90	35.56	94	46.81	76	27.63	70	31.43	74	6.76	76	47.37	79	8.86	84	5.95	85	27.06
138	26.09	146	42.47	144	25.69	122	31.15	131	10.69	137	34.31	142	11.97	146	4.79	144	40.28
192	41.15	197	37.06	191	18.85	188	26.06	188	9.04	190	45.79	188	5.32	144	7.64	141	21.99
3	66.67	10	30.00	13	30.77	2	0.00	5	0.00	9	33.33	21	19.05	21	4.76	18	22.22
42	21.43	60	26.67	53	7.55	38	39.47	49	20.41	44	50.00	55	7.27	56	12.50	52	11.54
295	28.14	374	30.48	332	30.12	89	29.21	158	5.70	211	37.44	341	9.38	338	6.51	258	17.05
390	19.74	458	31.22	353	21.25	262	14.89	334	17.96	314	42.68	382	6.54	352	13.07	345	13.62
146	31.51	181	8.29	233	13.30	162	4.94	292	6.85	214	46.73	285	5.26	290	32.07	244	28.69
276	21.74	301	37.54	274	21.90	215	9.77	227	5.29	267	33.71	295	8.81	228	7.46	296	24.32
62	16.13	99	25.25	85	24.71	39	17.95	63	7.94	60	40.00	85	10.59	80	12.50	77	19.48
9	22.22	15	33.33	29	6.90	9	44.44	16	25.00	15	46.67	33	6.06	19	10.53	21	19.05
132	27.27	146	36.99	122	18.85	74	18.92	93	9.68	98	38.78	129	6.20	123	13.01	122	27.87
132	37.12	140	37.14	171	27.49	76	31.58	96	6.25	136	36.76	217	9.68	187	17.11	163	38.65
74	13.51	93	41.94	74	18.92	36	19.44	65	10.77	61	27.87	84	7.14	83	15.66	79	31.65
143	28.67	179	40.22	166	28.31	80	18.75	128	10.16	120	28.33	178	6.18	176	19.32	163	25.77
72	33.33	93	30.11	30	13.33	14	0.00	19	5.26	21	52.38	35	8.57	33	6.06	28	21.43
50	32.00	50	26.00	33	15.15	14	7.14	21	4.76	21	42.86	34	5.88	30	23.33	28	53.57
177	36.16	207	46.38	124	21.77	66	10.61	81	11.11	97	36.08	137	13.14	142	18.31	134	29.85
90	24.44	100	23.00	124	12.90	66	10.61	116	6.03	99	45.45	131	4.58	139	19.42	130	24.62
22	45.45	28	50.00	23	8.70	17	0.00	20	10.00	18	38.89	25	4.00	25	20.00	24	45.83

Fig. 1. Two dimensional expression of multidimensional scaling applied to Smith's MMD based on 17 crown traits in 31 Asian populations. Proportion of variation explained by axis 1 and 2 is 36.8% and 23.1%, respectively.

and Cusp 7 in LM1, and Y groove pattern in LM2, while traits with a relatively low frequency were tuberculum dentale in UI2 and lingual cusp number in LP2, protostylid, DW and DTC in LM1.

The principal coordinate plot for these 17 sets of scores, based on Smith's MMDs and standard deviations, is shown in Fig. 1. Data from Sundadont and Sinodont populations were differently positioned on the right and left half of the first axis. The Miao located in the intermediate position on the first axis between the Sinodont and Sundadont populations, but it deviates slightly in the Sundadont being close to other Chinese minorities, the Naxi.

Table 25. Mesiodistal (MD) and buccolingual (BL) diameters in the Miao.

	Male				Female			
	MD	N	Mean	S.D.	N	Mean	S.D.	p (sex)
Upper I1	36	8.21	0.49	58	7.95	0.61	*	
I2	36	6.61	0.82	59	6.31	0.80		
C	38	7.84	0.60	60	7.64	0.50		
P1	38	7.20	0.41	60	7.11	0.49		
P2	36	6.76	0.47	58	6.68	0.46		
M1	37	10.37	0.59	58	10.11	0.62	*	
M2	35	9.96	0.62	51	9.47	0.60	**	
M3	12	8.82	0.86	12	8.19	1.15		
Lower I1	38	5.22	0.37	62	5.16	0.44		
I2	38	5.90	0.49	62	5.80	0.47		
C	38	7.01	0.39	62	6.55	0.42	***	
P1	38	7.12	0.43	60	7.05	0.49		
P2	37	7.07	0.49	61	6.95	0.53		
M1	32	11.38	0.55	52	10.94	0.62	**	
M2	36	10.77	0.66	52	10.35	0.70	**	
M3	11	10.58	0.78	12	9.87	0.77	*	
BL								
Upper I1	36	6.98	0.68	58	6.66	0.60	*	
I2	36	5.96	0.62	59	5.77	0.77		
C	38	8.14	0.57	59	7.76	0.56	**	
P1	38	9.05	0.55	60	8.88	0.67		
P2	36	9.08	0.50	58	8.88	0.68		
M1	37	11.16	0.56	59	10.87	0.64	*	
M2	36	11.56	0.65	56	11.04	0.72	***	
M3	16	10.85	0.67	16	9.84	1.66	*	
Lower I1	36	5.98	0.59	60	5.75	0.50		
I2	37	6.27	0.56	62	6.16	0.58		
C	36	7.89	0.60	62	7.29	0.57	***	
P1	38	8.06	0.57	60	7.70	0.57	**	
P2	37	8.41	0.52	61	8.14	0.53	*	
M1	33	10.82	0.54	54	10.41	0.62	**	
M2	37	10.71	0.62	57	10.29	0.68	**	
M3	13	10.45	0.79	18	9.99	0.45	*	

* 5%, ** 1%, *** 0.1%

Table 25 shows the means and standard deviations of mesiodistal and buccolingual diameters in the Miao, respectively. Both diameters have many significant sex differences, although probabilities were generally higher in buccolingual diameters than in the mesiodistal diameters.

Discussion

The population of the Miao, about 8,940,000 now, is larger than most of minority groups in China. After immigration in a long history from Southeast Asian countries, today they live mainly in Guizhou, Yunnan, Hunan, Hubei, Hainan Provinces. They are divided into several branches, such as Black Hmong, White Hmong, Striped Hmong, etc. (1).

The Miao language, which belongs to the Miao-Yao group of the Sino-Tibetan phylum, has developed into three dialects. Due to a long time living with the Han and other people, they can also speak the Chinese, Dong and Zhuang languages. They have been writing their own Miao language based on Latin since 1956. The staple food of the Miao ethnic minority is rice. Other dishes are meat and acidic soups. Pickled vegetables, hot seasonings and home-made wine are common at the table (1).

There were two epoch making studies on dental anthropology in Asia: "Mongoloid dental complex (25)" and "proposition of Sundadont and Sinodont (10)." The former explained that Asian people had particular set of teeth called such as shovel-shaped incisor, deflecting wrinkle in lower molars and third molar missing. The latter showed that there were two major morphological variations among Mongoloid populations, Sinodont and Sundadont, describing the combined dental characteristics of the Northeast and Southeast Asian populations, respectively. The Han, the majority of Chinese people, belongs to Sinodont in this context. However, there are 55 minorities in China whose dental anthropological positions have not been known yet.

The dichotomized frequencies of the Miao compared with those of the other East Asian populations revealed that Miao dental characteristics resembled those of Sinodont populations more closely than those of Sundadont populations on UI1 shoveling, while on UI1 double-shoveling and deflecting wrinkle. Miao dental characteristics resembled those of Sundadont populations more closely than those of Sinodont populations. Thus, Miao dentition showed both Sundadont and Sinodont characteristics.

The trait, double-shovelling, characterized by the

presence of mesial and distal ridges on the labial surfaces of the upper anterior teeth, is a key trait of the Sinodonty which is said to be developed as an adaptation to a cold climate or hunter-gathering life style (26, 27). The frequency of this trait is relatively low in the Miao, placing them in closer affinity to Sundadonty.

Protostylid is also a key trait for Sinodonty (8). This trait appears on the buccal surface of the protoconid of the lower molar. It is frequently, though not invariably, associated with the buccal groove separating protoconid and hypoconid. The lowest frequency of this trait in Miao among 5 minorities indicated their close position to Sundadonty. These results therefore indicate that the Miao occupies an intermediate position between Sundadonty and Sinodonty. High frequencies of Cusp 6 and Cusp7 in LM1 and YGP in LM2 in Miao showed that the Miao retain basic crown characters compared with other minorities.

As in the Fig. 1, the generalized position of the 5 groups of the Chinese minorities occupied lower left corner of the coordinate axis. This implies that these 5 minorities belong to Sundadont, but they are alike in their dental trait frequency, and slightly different from other Sundadont groups.

Thirty East Asian populations compared with the Miao in this study were 15 Sinodont and 16 Sundadont populations. The Northeast and Southeast Asian populations corresponded to Sinodont and Sundadont in Turner's classification were separated out in negative and positive directions on the first principal coordinate of the principal coordinate analysis, as seen in Fig. 1. A multiple regression analysis demonstrated that the first principal coordinate correlated positively with UI1 shoveling, UI1 double-shoveling, lingual cusp number in LP2 and DW in LM1, on the other hand, the second principal coordinate correlated with DAR in the UC, lingual cusp number in LP2, Cusp 5 and Carabelli's cusp in UM1. The contribution was 36.8% on the first axis and 23.0% in the second axis.

A direct comparison of the means of the mesiodistal and buccolingual diameters was done with the use

Fig. 2. Mean MD diameter in several Asian populations in males (upper) and females (lower) including Chinese minorities.

of the result of the other minority groups, the Hani and the Dai (28) and the Naxi and the Pumi (29). Both mesiodistal and buccolingual diameters in the Miao were smallest among five groups in almost all teeth in the male and female (data not shown). Fig. 2 shows the inter-population comparison of the tooth size representing the mean of total size of mesiodistal diameters in maxillary teeth from I1 to M2 in Chinese minorities and other Asian populations.

The total tooth size of the Miao showed smallest value among 5 minorities. It has been reported that there is a wide variety of the dimensional characters of the body in Chinese minorities (3, 4). The Miao is grouped in the small size group of the body compared with other four groups. For example, averages of the stature (S) and head length (HL) in young adult males in the Miao, Pumi and Dai are as follows:

Miao (S) 153.3 cm (HL) 18.0 cm, Pumi (S) 166.5 cm (HL) 19.4 cm, Dai (S) 161.9 cm (HL) 18.9 cm (2, 3, 4) respectively. Direct correlation between tooth size and body size in individuals is not reliable, but they can be compared statistically among peoples with close affinity. The small size of the Miao teeth might reflect their small size of the body.

In Fig. 2, the larger tooth groups than Chinese minorities were Japanese and Philippines 1 which were cited from the studies by ourselves (28, 30). Japanese samples were from university students in Chiba, Japan. Philippines 1 was collected from children in highly educated class in Manila (30). The smaller tooth groups were cited from two groups of the Tibet and Philippines. The Tibet sample was cited from Sharma (31) which reported the size of the Tibetan immigrants and described that their teeth were the smallest in the world. The Philippines 2 was cited from our study from Potter (32). Potter's study is also one of the smallest teeth ever reported.

Miao teeth are small among minorities and East Asians, but not so small as in Southeast Asians and Tibetans. It is pointed out that one of the peculiar characters of Sundadonty is the small tooth size compared with Sinodonty. The relatively small size of the teeth in the Miao might suggest that they belong to Sundadont population.

Tooth size varies chronologically and geographically, even in a single population without any change of gene flow (33-38). However, it is also suggested that the current information was inadequate and speculative on the causation of tooth size enlargement in recent populations (39).

The results we obtained for the Miao population showed that it located Sundadont dental variation category, which typifies Southeast Asians. Although anthropological affinity of the Miao tribe is complicated, more detailed dental anthropological studies of minority groups will help the understanding of their history and affinity.

Conclusion

The frequencies of 22 dental traits and tooth size in Chinese ethnic minority, the Miao tribe were inves-

tigated. The results were compared with the Dai, Hani, Pumi and Naxi of the Chinese minorities, and those of other Asian populations in terms of Turner's Mongoloid dental variation theory. The traits which showed comparatively high frequency in the Miao were shoveling of the upper central incisor and Cusp 6 while traits with a low frequency were double-shoveling of the upper central incisor and protostylid in the lower first molar. The tooth size of the Miao was smallest in the 5 Chinese minorities. A principal coordinate analysis based on Smith's Mean Measure of Divergence using the frequencies of the 17 traits, suggested that the Miao tribe occupied the position in the Sundadont dental variation range, which typifies Southeast Asians, but peculiar position among Chinese minorities. Smallest size of the teeth may reflect their ethnic affinity more strongly to Sundadonty.

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